

Remarks

The Examiner has rejected claims 1, 11-13, 17, and 22-24 under 35 U.S.C. §103(a) as unpatentable over Pu et al. U.S. Patent No. 6,825,618 in view of Brcka U.S. Patent Publication No. 2001/0022158. Dependent claims 2 and 15 were rejected over these two references in further view of Davis et al. U.S. Patent No. 6,685,799. Dependent claims 3, 4 and 6 are rejected over these three references in further view of Tdorov et al. U.S. Patent Pub. No. 2003/0006009. Claim 1 is further rejected on the ground of nonstatutory obviousness-type double patenting based on Brcka U.S. Patent No. 6,237,526 in view of Pu et al.

Claims 1, 2 and 17 are being canceled to simplify the issues. Claim 11 is being rewritten in independent form. This amendment, which only cancels claims, should be entered in that it raises no new issues and places the application in better condition for either allowance or appeal. It is requested that the Examiner reconsider the rejection of claims 11 and 22 and their dependent claims.

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In the Office Action, claim 22 is discussed by incorporating the discussion of the rejection of claim 1. Not all of the language of claim 22 was discussed in the rejection. Claim 22 contains elements that none of the references discloses.

Independent claim 22 claims an ICP source ... comprising:

a dielectric chamber wall ...
a peripheral ionization source that is configured to couple energy through the dielectric chamber wall in a ring-shaped distribution into the chamber, ...
the peripheral ionization source having a segmented configuration ..., ... in an alternating high and low power distribution to produce a stationary ring-shaped plasma of alternating high and low density in the chamber [certain structure omitted].

Examples of such a power distribution producing the ring-shaped plasma of alternating high and low density are illustrated in Figs. 2D and 2F in the present application. Pu et al. does not expressly describe the use an alternating high and low power distribution to produce a

stationary ring-shaped plasma of alternating high and low density. The features is not inherent in Pu et al. either. It is incorrect to equate a configuration wherein “coils produce a magnetic field of opposite polarity” with “alternating high and low power distribution”, as stated on page 3 of the Office Action. It is further erroneous to assume that coils of opposite polarity necessarily produce a “plasma of alternating high and low density in the chamber.”

The Pu et al. reference states:

“The invention can produce a plasma adjacent a semiconductor workpiece in a plasma chamber having excellent spatial uniformity, i.e., uniformity in both the radial dimension and the azimuthal dimension. The plasma has excellent radial uniformity because the adjacent sides of adjacent coils are approximately parallel. It has excellent azimuthal uniformity because the coils are equally spaced azimuthally relative to the geometric surface.” [Col. 2, lines 19-26.]

Arguably, it can be said that everyone wants to produce a uniform plasma close to the wafer being processed. It can also be argued that any geometric variation in a plasma source will produce some variation in plasma density somewhere in a chamber. But Pu et al. maximize uniformity of the plasma by the spacing between the perimeters of adjacent coils. Applicant, on the other hand, exploits variations in the source to deliberately produce the described plasma density variations. The structure that produces the variations is also recited in claim 22:

... the peripheral ionization source including a low inductance RF antenna
... and producing an annular magnetic field ... and
“the peripheral ionization source having a segmented configuration of alternating high and low-radiation segments arranged in a ring, ...”

The Pu et al. coil structure in which separate stacked windings surround magnetizable core material produces exceptionally high inductance, where Applicant’s simple large loops of large conductors necessarily produces impedance that is relatively low for the application. Pu et al.’s need to insure that each coil loop has a chamber-side ground to reduce voltage close to the chamber is a direct result of Pu et al.’s high impedance coils. High inductance is what causes the high coil voltage that makes Pu et al.’s coil grounding scheme necessary to avoid excess capacitive coupling.

Applicant prevents this high voltage by creating a segmented source with an antenna having low inductance. This inductance is low relative to a typical antenna, and is very low relative to Pu et al.’s coil design. This is particularly relevant to Applicant’s claim 23.

Structure of Applicant's source, as recited in claim 22, includes a segmented configuration of alternating high and low-radiation segments. In claim 23, these high and low radiation segments are recited as respectively including high-efficiency sections and low-efficiency sections of the antenna. In claim 24, the high and low efficiency antenna sections are recited as being formed of small cross-section conductors close and the relatively large cross-section conductors, respectively. See Figs. 2, 3-3E, 4-4F and 5-5B, for example.

Further, in claims 3-7, the high and low radiation segments are recited as respectively including a shield with high-transparency sections having a plurality of slots therethrough and low-transparency sections that are electrically conductive and generally solid relative to the high-transparency sections. See Figs. 2, 2D, 2E, 4-4B, 4F, 6B, 6E, 6H, and 7A-7C, for example.

Pu et al. teach none of the features claimed by Applicant that are emphasized above.

As for the secondary references, Brcka shows a source antenna having a ring of loops (Figs. 6A-D and 7D) formed of a conductor of constant cross-section, without the alternating polarity or exceptionally high inductance of Pu et al., but that still necessarily presents more inductance than common helical or spiral coils. Brcka shows slotted shields (see Brcka's Figs. 11A-11C and Applicant's Fig. 2A), but they are not segmented.

Davis et al. discloses a shield with adjustable segments so that the shield efficiency can be varied to stabilize the plasma, not to provide alternating high and low plasma density.

Todorov et al. is cited as disclosing a shield that includes a plurality of slots separated by conductive material, interpreting each slot as a "high transparency section" and each conductive portion as a "low transparency section". That interpretation is not a valid stretch of the terms. A high transparency shield section is not one slot, but a plurality of slots separated by conductive strips, as in Applicant's claim 3. With the proper proportion of slot width to conductor width for a particular RF frequency, the entire Todorov et al. shield is high transparency to magnetic fields, which is typically what is intended. The Todorov et al. shield is not an alternating high and low transparency shield and will not have the claimed effect on the plasma power distribution and density.

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Accordingly, no combination of the applied references produces the features or functions that are claimed by Applicant in claims 22 and its dependent claims. Accordingly, no *prima facie* case of obviousness has been made as to claim 22 or the claims dependent thereon.

For the same reasons, the corresponding features of the source of claim 11 and its dependent claims are missing from the cited references.

The double patenting rejection of claim 1 has been mooted by the cancellation of claim 1.

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For the reasons stated above, it is submitted that the claims are allowable. An early allowance is respectfully requested.

Respectfully submitted,

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